For thousands of years, the high ground has been used during conflicts to gain a tactical advantage.
Through the centuries, the high ground has been used for early warning, preparation of the battlefield, long distance communications and leveraged force application.

We have protected our cities by building tall walls, and lit fires on hilltops to communicate over long distances. With the age of flight, we were able to occupy even higher ground -- first with Balloons in the 18th century, and then aircraft in the 20th century.

When the space age dawned in 1957, the Department of Defense was motivated to create DARPA. This newly formed agency was tasked with securing space, the ultimate tactical high ground, for our nation and the rest of the free world.

Today, DARPA is back in space. You will hear about our interest in both space based engagement and space mission protection today. First, let's discuss space based engagement.

This category includes the intelligence surveillance and reconnaissance (ISR) functionality required to find and target the enemy as well as the communications capacity required to distribute that information across the theater of operations. With the chain of command spanning thousands of miles, this communications theater of operations is global, and will continue to be so moving into the future.

One big example of a current space based engagement initiative is the Innovative Space Based Radar Antenna Technology - or ISAT - program. ISAT is creating the huge radar antenna technology required to provide war fighters with continuous, global, tactical-grade tracking of ground moving targets (GMTI).

Global means space - there is no better way to get immediate, deep visibility of what the enemy is doing. Unlike aircraft, Keplarian laws dictate flight paths, so space overflight is not considered offensive.
Furthermore, ISAT can achieve the desired persistent global coverage without the logistics tails and fly-out times that airborne assets require.

The continuous coverage we desire requires overlapping satellite footprints and high enough grazing angles so that time critical targets can always be tracked, despite real world obstacles like topography, tree lined roads and urban canyons. It turns out that this can be accomplished with either about a dozen satellites in mid earth orbit or about a hundred satellites in low earth orbit.

As long as economics dictate that a dozen enormous satellites in mid earth orbit are cheaper than a hundred very large satellites in low earth orbit, then mid earth orbit is the right answer. To detect slowly moving targets, resolve those targets, and accurately track them, we need an enormous 300m long 1000 m2 antenna. To achieve the desired aperture, the ISAT program is developing two specific large space aperture technologies. The first is an antenna structure which, when deployed, unpacks and grows by a factor of 100.

3m when stowed, 300m when deployed. Even with the materials we are using for ISAT, the 300m long structure will not be perfectly rigid. So we are also developing the novel calibration and metrology techniques that can calibrate that 300m long antenna down to an accuracy of 1.5 mm. DARPA's goal is to launch, deploy, measure and calibrate a huge demonstration antenna by the end of 2009.

Similar technology is needed for the integrated sensor is structure - ISIS - project that you heard about earlier. ISIS will use similar lightweight structures, aperture technology and calibration techniques for a huge stratospheric airship that will provide the surge in local surveillance and communications capacity required when we have hundreds of thousands troops deployed in the theater.

Moving beyond ISAT, the Virtual Space Office is now interested in a new dimension in novel space apertures -- compression in two dimensions rather than just one. While the long, thin ISAT aperture is ideal for GMTI, the airborne MTI, communications and signal intercept missions all desire apertures that are nearly square. Deploying large, square, electronically scanable apertures in space adds a whole new dimension to the problem - literally.

The term large is relative. 20m2 is large for a micro satellite in the same way that 1000m2 is large for the ISAT satellite that fills our largest launch vehicle. Finding ways to pack roughly 20m2 of aperture into a microsat is of particular interest to DARPA, as it opens up many possibilities. For example, with a 20m2 aperture, a microsat in mid earth orbit can provide high data rate communications to a low power hand held radio.

In an age where our cell-phones take megapixel photographs, and high quality video is on the horizon, providing the warfighter with the capacity to send and receive this type of information in a timely fashion would be transformational.

A 20m2 aperture on a microsat also enables several tactically responsive space missions like synthetic aperture radar imaging, signal intercept, geolocation and communications, where extra capacity or capability may be required at short notice. To be tactically responsive, we must be able to launch quickly, and it is easier, and therefore quicker, to launch something small.

However, we cannot sacrifice capability for size, so we need to find a way to pack a lot of aperture and capability into a small package. Microsats and tactically responsive spacecraft are also an import part my next subject, space mission protection. The Rumsfeld Space Commission, which raised the spectre of a "Space Pearl Harbor," said, "the security and economic well being of the United States and its allies and friends depends on the nation's ability to operate successfully in space."

Our military uses space for surveillance, long haul communications and the accurate location of troops and weapons. Denial of these space services would severely hamper our armed forces. A perfect example of our commercial dependence on space is the malfunctioning of the Galaxy IV satellite in 1998. Eighty percent of US pagers, along with video feeds for cable TV and data for much of the ATM network, were shut down. It took weeks to fully restore all the services.

There are many threat modalities in space, kinetic anti-satellite weapons and space junk, deliberate jamming, and high altitude nuclear detonations that would expose our satellites to dangerously high levels of radiation. Situational awareness, both global and local, is key to dealing with the anti-satellite weapon and space junk threat. You have just heard about our Space Surveillance programs in this area. The situational awareness must be coupled to the ability to either maneuver out of harm's way or launch countermeasures in time.

In order to protect our space infrastructure, launch on demand to inspect the threat or provide the countermeasure is required. You have just heard about our responsive launch programs in this area.

However, if satellites are lost, part of space mission protection is the ability to replenish that lost capability quickly. To fill this second need we are interested in concepts that can deploy a whole constellation of microsats from a single launch vehicle. In both cases, protecting our assets and replenishing lost capability, we need payloads that are small and easy to launch yet highly capable once deployed. To secure space - the ultimate high ground - we need to think small on launch, but big in space.

As you can see, there is plenty of opportunity to help us exploit and protect the high ground. We have several programs, but still many more questions than answers. If you want to learn more, if you have better ideas or if you have new concepts, come and see us at the Virtual Space Office booth. Our office might be virtual, but our interest is real.